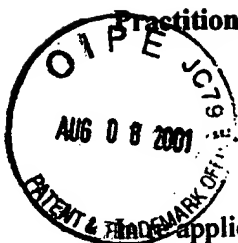


W 2661



Practitioner's Docket No. FR919990111US1

PATENT

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Application of: D. Orsatti

Application No.: 09/766,824 Group No.: 2661
Filed: 01/22/2001 Examiner:
For: Method and System of Transmitting Loopback Cells Through a Switching Node of an Asynchronous Transfer Mode (ATM) Network

Assistant Commissioner for Patents
Washington, D.C. 20231

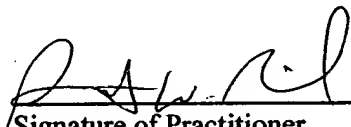
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Country: Europe
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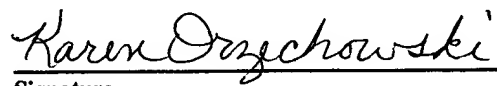


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Zeichen/Ref./Réf. FR 9 1999 0111	Anmeldung Nr./Application No./Demande n°./Patent Nr./Patent No./Brevet n°. 00480021.5 2216
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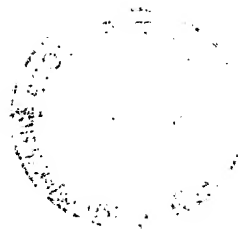
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00480021.5

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Anmeldung Nr.:
Application no.: 00480021.5
Demande n°:

Anmeldetag:
Date of filing: 22/02/00
Date de dépôt:

Anmelder:
Applicant(s):
Demandeur(s):
INTERNATIONAL BUSINESS MACHINES CORPORATION
Armonk, NY 10504
UNITED STATES OF AMERICA

Bezeichnung der Erfindung:
Title of the invention:
Titre de l'invention:

Method of transmitting loopback cells through a switching node of an asynchronous transfer mode (ATM) network

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

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**METHOD OF TRANSMITTING LOOPBACK CELLS THROUGH A SWITCHING NODE
OF AN ASYNCHRONOUS TRANSFER MODE (ATM) NETWORK**

Technical field

5 The invention relates generally to the Asynchronous Transfer
Mode (ATM) network wherein a connection is established between
a source ATM device and a destination ATM device by the
intermediary of a plurality of network switching nodes, and
relates in particular to a method of loopbacking loopback cells
from the connection output adapter in one of the switching
10 nodes located on the route used by the connection.

Background

15 The use of ATM switching nodes in an IP network has become the
most attractive solution since ATM hardware switches have been
extensively studied and are widely available in many different
architectures.

When a connection is established in the ATM network from a
source ATM device to a destination ATM device by the
intermediary of a plurality of switching nodes, the incoming

cells to a switching node are automatically routed to the next switching node of the connection. For this, each cell is composed of an ATM header and of a payload. The ATM protocol engine of the switching node identifies the incoming ATM cell using a lookup table. In the case of a valid cell (valid means belonging to an existing connection), the protocol engine performs traffic management function (traffic policing, congestion management, priority management) and queues the cell in an appropriate queue. A scheduler using priority based scheduling procedures selects queues from which cells are to be transmitted. Those cells are dequeued from their queue. Prior transmission, the protocol engine adds routing labels to the cell : the switch routing label (SRL) and the protocol engine correlator (PEC). The resulting internal cell format used within the switching node will be denominated hereafter labeled cell. The SRL contains either explicitly the destination blade or a pointer to a translation table located in the switching device and containing the explicit destination blade. The PEC is a pointer used by the protocol engine of the output adapter to identify the connection. The protocol engine in the output destination adapter receives the cell from the switching device. Similarly to the input protocol engine, it identifies the incoming cell by performing a lookup function on the appended protocol engine correlator, runs traffic management functions, queues the cell in the appropriate queues, dequeues the cell under control of a scheduler, removes the appended labels, swaps the ATM label and transmits the cell on the connection destination ATM port(s).

The ATM standards have defined Operation And Maintenance (OAM) procedures. They are based on particular cells identified as OAM cells by means of particular values of the payload type indicator (PTI) field of the ATM cell header. Some ones of the OAM cells are called loopback cells. They can be either segment or end to end loopback cells and may contain optionnally in their payload a source and a destination address indication.

The ITU-T I610 specifications define the procedures to be performed by a network equipment when receiving OAM loopback cells. In particular they define two loopback locations for a switching node, the input adapter and the output adapter, and
5 the loopback condition algorithm using the cells parameters (source address, destination address, segment or end to end). These procedures, by allowing to loopback cells on a connection path, at various locations (input or output adapter of the various switching nodes on the connection path) are used either
10 to monitor the connection or for problem determination and failure isolation in the case of a failing connection.

When OAM cells such as loopback cells are received in a switching node a switching node of a connection, a classical way to process would be to transmit said cells to a dedicated
15 resource such as a local processor that would perform the OAM procedures. But, such a solution is not appropriate and is expensive inasmuch as it requires to incorporate microprocessors on the adapter card of the switching node whereas the normal connection cells use ASIC modules which are
20 data processing units specifically designed for the routing of the ATM cells.

Summary of the invention

Accordingly, the objet of the invention is to achieve a method using principally the normal resources of a switching node in
25 the transmission of the ATM cells, for loopbacking the loopback cells from the adapter used as output adapter by the connection to the adapter used as input adapter by the connection.

The invention relates therefore to a method of transmitting a loopback cell of a connection established between a source ATM
30 device and a destination ATM device of an ATM network, the loopback cell being loopbacked in one of the switching nodes located on the connection route, said loopback cell ingressing

the switching node by a port P1 of adapter B1, said loopback cell being switched to the adapter B2 as normal cells of the connection, and being then switched backward to adapter B1 and egressing the switching node by the same port P1 of the same adapter B1 as output adapter instead of port P2 of adapter B2 as output adapter used by normal cells of the connection. The method comprises the steps of detecting in adapter B2 whether the incoming cell includes a loopback condition, and if so, appending to the incoming cell a specific routing label indicating that the incoming cell is a cell to be loopbacked on the connection and using said routing label by the protocol engine of adapter B2 to transmit said cell over the switch engine to adapter B1, then over the ATM network from port P1 of adapter B1.

15 **Brief description of the drawings**

The above and other objects, features and advantages of the invention will be better understood by reading the following more particular description of the invention in conjunction with the accompanying drawings wherein :

- 20 - Fig. 1 represents a block diagram of an ATM network including several switching nodes through which a connection is established and in which the routing of a loopback cell according to the method of the invention is schematically represented.
- 25 - Fig. 2 and 3 are block diagrams representing the two half duplex flows of an ATM connection cell between port P1 to port P2 of a switching node through which an ATM connection is established.
- Fig. 4 is a block diagram representing the flow of a loopback cell from port P1 of an adapter B1 to the internal port of adapter B2 of the switching node according to the principles of the invention.
- 30 - Fig. 5 is a block diagram representing the flow of a loopback cell from the internal port of adapter B2 to port P1

of adapter B1 of the switching node according to the principles of the invention.

- Fig. 6 is a flow chart representing the steps of the method according to the invention.

5 Detailed description of the invention

Fig. 1 shows an example of an ATM network 10 implementing the system according to the invention, and comprising four switching nodes 12, 14, 16 and 18 being respectively connected to local consoles 20, 22, 24 and 26. Each switching node is
10 composed of a Control Point (CP) blade and a plurality of adapter blades, which provide the physical attachments to network devices such as the other switching nodes or the user workstations and a switch engine (X) providing cell switching between its ports on which are attached the adapter blades. The
15 local console attached to the CP blade in each node is used for the network and control management. Note that each blade includes an input and an output adapters.

It is assumed that a connection in dotted lines in Fig. 1 is established between the source switching node 12 and the
20 destination switching node 18 through the intermediary switching nodes 14 and 16. For this connection, a cell inputs each switching node by an input adapter and outputs the switching node by an output adapter after being switched by the switch engine of the node to be transmitted to the output
25 adapter as a normal connection cell. But, instead of being transmitted over the network, the loopback cell is transferred towards the input adapter of the switching node from which it is loopbacked over the ATM network on the reverse path of the full duplex ATM connection.

30 As illustrated in Fig. 2, the transfer of normal ATM cells through a switching node is as follows. The ATM cells of a given connection are received by a port P1 of the input adapter

B1. They are composed of a ATM label VP1-VC1 (virtual path-virtual circuit) and a payload. First, the protocol engine of adapter B1 identifies the incoming cell using the ATM label lookup 40. The lookup function is in fact an address resolution performed on the source port P1 and the ATM label VP1-VC1. The lookup result is a pointer to the connection control block LCBA1 (leaf control block address). The connection control block contains the information necessary to process the incoming cell, that is information used to run the traffic management function and information used to forward the cell: a switch routing label SRL (B2) and a protocol engine correlator PEC which is the pointer in the output adapter used to perform the label swap (LCBA2). Then, the protocol engine enqueues the cell in an appropriate queue 42. A scheduler using priority based scheduling procedures selects the queue from which the cells are to be transmitted and dequeues those cells from the selected queue. Then, the append routing header function 44 appends the switch routing label B2 and the protocol engine correlator LCBA2 to the cell which is transmitted to switch engine 46.

Using the appended SRL B2, switch engine 46 transmits the cell to the output adapter B2. Similarly to the protocol engine of the input adapter, the protocol engine of the output adapter identifies the cell by performing a lookup on the appended PEC LCBA2 (48), runs traffic management functions, queues the cell in the appropriate queue 50 and dequeues the cell under the control of a scheduler. Then, the routing labels B2 and LCBA2 are removed by remove label function 52, and the ATM label is swapped to the new label pointed by LCBA2 in the connection control block, that is VP2-VC2. At last, the protocol engine transmits the cell on destination port P2 also pointed by LCBA2 in the connection control block.

Reciprocally, when a cell is received by port P2 of input adapter B2, its ATM header is VP2-VC2 as illustrated in Fig. 3.

The pointer to the connection control block resulting from the label lookup is the pointer LCBA2 which points in the control block to the switch routing label SRL B1 and the protocol engine correlator (PEC) LCBA1 used as pointer to the connection control block in output adapter B1. These two labels are appended to the cell before transmitting it to switch engine 46. Then, in output adapter B1, the routing labels are removed and the ATM header is swapped to VP1-VC1 given by pointer LBA2 in the connection control block of adapter B1.

It is clear from the above description that the connection control block pointers LCBA1-LCBA2 for the P1 to P2 half-duplex connection, are the same as connection control block pointers for the P2 to P1 half-duplex connection. Thus, the connection being full duplex, symmetrical operations are performed on the cell flow received by port P2 of adapter B2 and the cell flow received by port P1 of adapter B1. Such symmetrical operations are being used to achieve the invention as explained hereafter.

It is assumed now that the incoming cell is a loopback cell to be transmitted to adapter B2 as illustrated in Fig. 4 before being loopbacked towards adapter B1. In such a case, the incoming cell includes an indication that it is a loopback cell to be loopbacked at the output of adapter B2 towards adapter B1 instead of being transmitted over the network from port P2 of adapter B2. Therefore, the processing of the cell is the same as for a normal connection cell explained in reference to Fig. 2 until the cell is switched by switch engine 46 towards adapter B2.

In output adapter B2, the protocol engine determines, using the OAM procedures, that the cell has to be loopbacked and sets a loop condition bit in a specific register or in the cell buffer control block. At this stage, it is useful to mention that a loopback may not be allowed in the switching node being considered. For this, a loop control bit has to be set by the

control point of the switching node in the connection control block for the loopback to be allowed. If the loop control bit is set, a loopback flag is added to the cell.

5 After the cell is queued in a selected queue 50 and dequeued, the remove label-ATM label swap function 52 utilizes pointer LCBA2 to get from the connection control block the information used to forward the cell, that is the target port indication P2 and the new ATM label used to perform the label swap. Accordingly, the label VP1-VC1 is replaced in the cell by the
10 label VP2-VC2 as ATM header, and in view of the loopback flag included in the cell, the pointer LCBA2 is replaced by the target port indication P2. Note that the above steps according to the method of the invention can be easily made either by hardware or by software.

15 Then, due to the loopback flag in the cell, this one is not forwarded over the network on port P2 as a regular cell of the connection, but is transferred to an "internal port" which is a special port of adapter B2 established between the output part and the input part of adapter B2 used for loopback cells only,
20 and the loopback flag is removed from the cell.

The internal port is in fact an input port for adapter B2 as illustrated in Fig. 5. But, insofar as the cell includes the label P2, the lookup function 40' of the protocol engine applies in a way identical to the one which would be achieved
25 in response to an incoming cell of the connection received on port P2. Afterwards, the remaining steps of the cell processing are identical to the processing steps already described in reference to Fig. 3.

30 The method according to the invention is represented by the flow chart illustrated in Fig. 6. After an incoming cell has been normally processed in adapter B1, it is received by output adapter B2 (step 60). A check is performed (step 62) to

determine whether loopback conditions are met. If so, a loop condition bit is set in a register or in the cell buffer control block (step 64). Then, the label lookup function is performed on the appended PEC LCBA2 to find the connection control block which contains the forwarding information, egress port P2 and ATM label VP2-VC2 at egress port, and the loop control bit. If the loop control bit is set (68), a loopback flag is appended to the cell (step 70). Due to the presence of this loopback flag, the SRL B2 and PEC LCBA2 which had been appended to the cell by the protocol engine of input adapter B1, are replaced by the egress port identifier P2 (72), and the ATM label VP1-VC1 is swapped to VP2-VC2 (step 73). Then, the cell is transferred to the input adapter B2 through the internal port of adapter B2 (step 74). In input adapter B2, the cell is processed regularly, i.e. a lookup function is performed on the input port P2 appended to the cell and on the ATM label VP2-VC2, the cell is switched to output adapter B1 and transmitted over the ATM network from output port P1 (step 76). When the cell does not meet loopback conditions or when the loop control bit is not set, the switch routing label B2 and the protocol engine correlator LCBA2 are removed from the cell (step 78), the ATM label is swapped from VP1-VC1 to VP2-VC2 (79) and the cell is transmitted over the network on output port P2 of adapter B2 as all regular cells of the connection (step 80).

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CLAIMS

1. Method of transmitting a loopback cell of a connection established between a source ATM device (12) and a destination ATM device (18) of an ATM network, said
5 loopback cell being loopbacked in one of the switching nodes located on the connection route, said loopback cell ingressing said switching node by a port P1 of adapter B1, before being switched to the adapter B2 as normal cells of the connection, and being then switched backward to adapter
10 B1 and egressing the switching node by the same port P1 of the same adapter B1 as output adapter instead of port P2 of adapter B2 as output adapter used by normal cells of the connection;

said method being characterized by the following steps :

- 15 - detecting in said adapter B2 whether the incoming cell includes a loopback condition, and if so
- appending to the incoming cell a specific routing label indicating that the incoming cell is a cell to be loopbacked on the connection and using said routing label
20 by the protocol engine of adapter B2 to transmit said cell through the switch engine to adapter B1, then over the ATM network from port P1 of adapter B1.

2. Method according to claim 1, wherein said specific routing label is appended to said loopback cell only if a loop
25 control bit is set by the control point of said switching node in said adapter B2.

3. Method according to claim 2, wherein said specific routing label is the identification of said output port P2 to indicate to the protocol engine of said adapter B2 used as
30 output adapter that said loopback cell will be considered

as a normal cell of said connection ingressing into said port P2.

- 5 4. Method according to claim 3, wherein a loopback flag is appended to said loopback cell if said loop control bit is set in order to indicate to the protocol engine of said adapter B2 used as output adapter that said identification of output port P2 has to be appended to said loopback cell.
- 10 5. Method according to claim 4, wherein said loopback cell is transferred to an internal port of adapter B2, said internal port being only used for loopback cells when said loopback flag is appended to said loopback cell.
- 15 6. Method according to claim 5, wherein said internal port is used as an input port of said adapter B2 used as input adapter for receiving said loopback cell which is considered as a normal cell of the connection ingressing into said port P2 used as input port in view of said identification of port P2 appended thereto.
- 20 7. System in a switching node (16) for transmitting a loopback cell comprising means adapted for carrying out the method according to any one of claims 1 to 6.

**METHOD OF TRANSMITTING LOOPBACK CELLS THROUGH A SWITCHING NODE
OF AN ASYNCHRONOUS TRANSFER MODE (ATM) NETWORK**

Abstract

Method of transmitting a loopback cell of a connection
5 established between a source ATM device (12) and a destination
ATM device (18) of an ATM network, the loopback cell being
loopbacked in one of the switching nodes (16) located on the
route used by the connection, and incoming into the switching
node by a port P1 of adapter B1 and going out of the switching
10 node by the same port P1 of the same adapter B1 instead of
adapter B2 used by normal cells of the connection. The method
comprises the steps of detecting in adapter B2 whether the
incoming cell includes a loopback condition, and if so
appending to the incoming cell a specific routing label
15 indicating that the incoming cell is a loopback cell to be
loopbacked on the connection so that the specific routing label
is used by the protocol engine of adapter B2 for transferring
said loopback cell to an input port of adapter B2 whereby the
loopback cell is transmitted over the ATM network from port P1
20 of adapter B1.

FIG. 1

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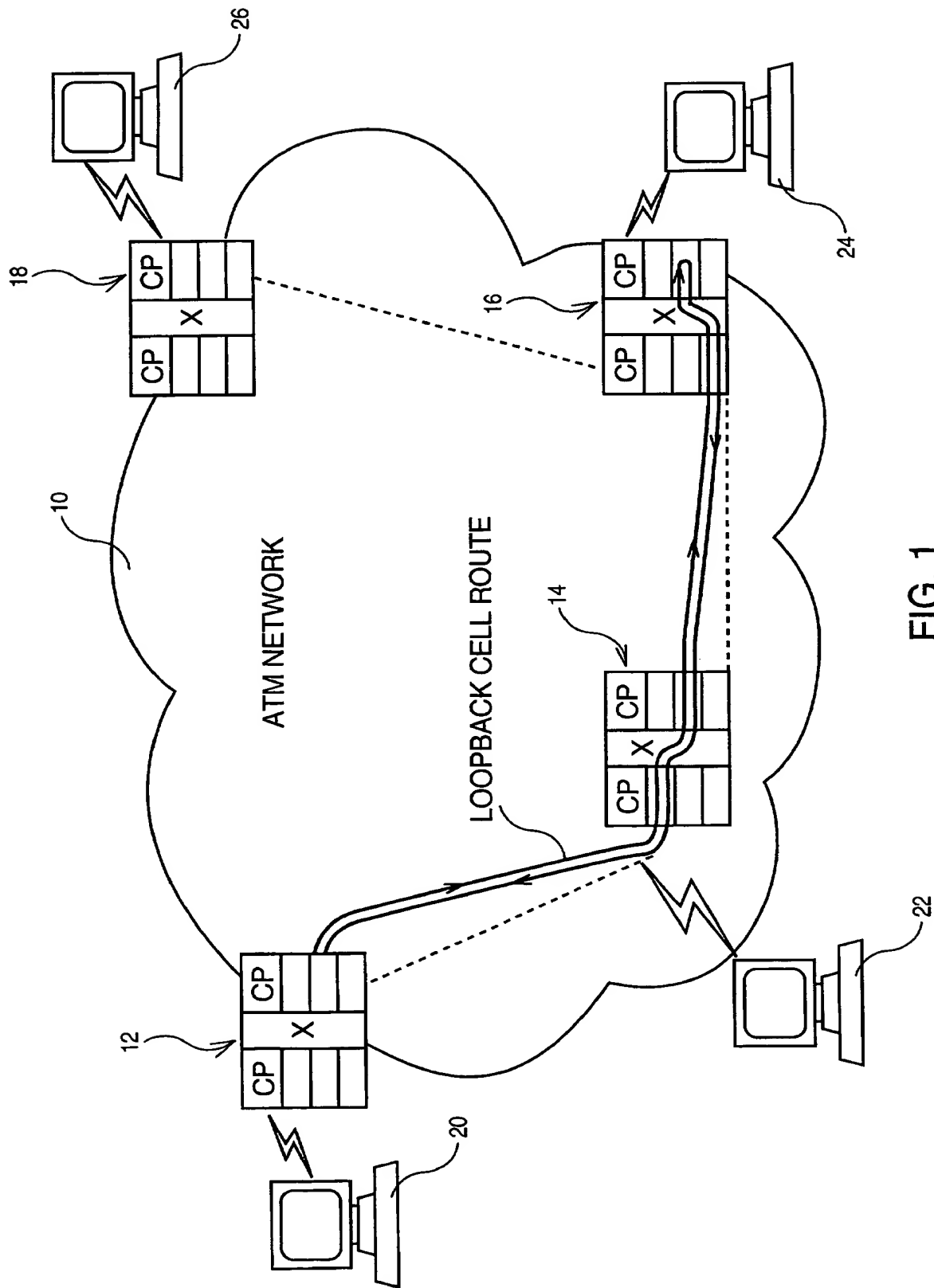


FIG. 1

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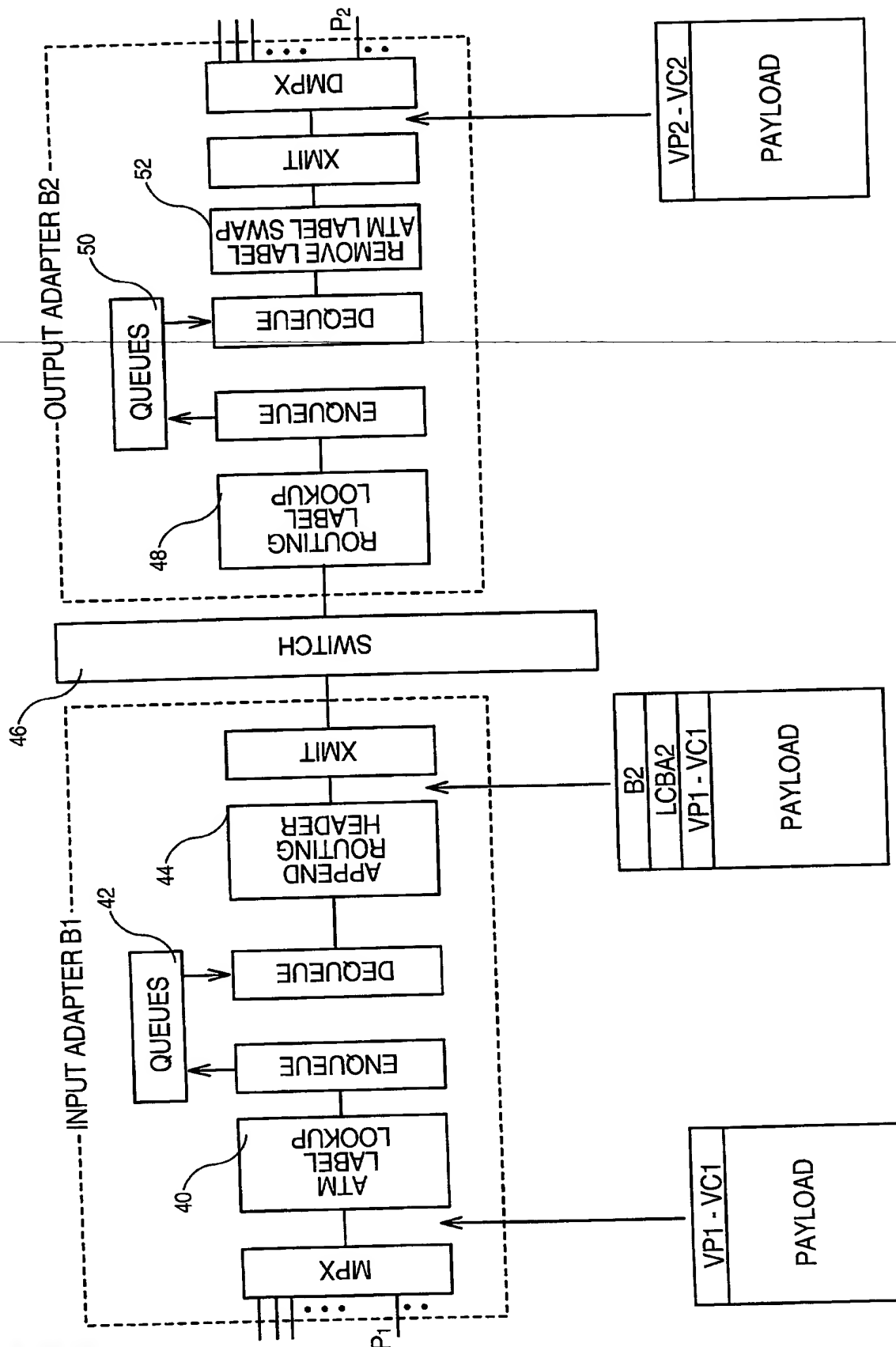


FIG. 2

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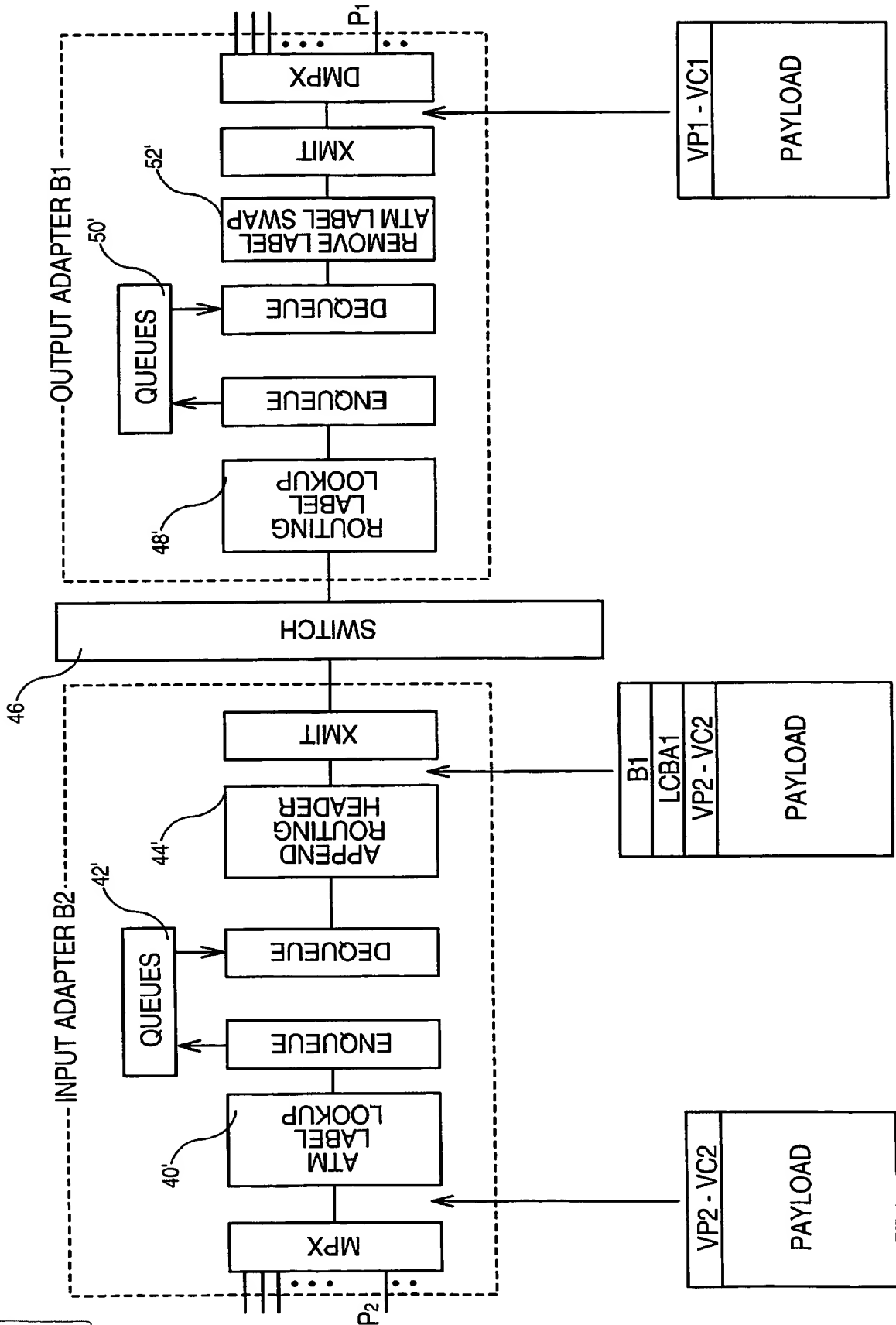


FIG. 3

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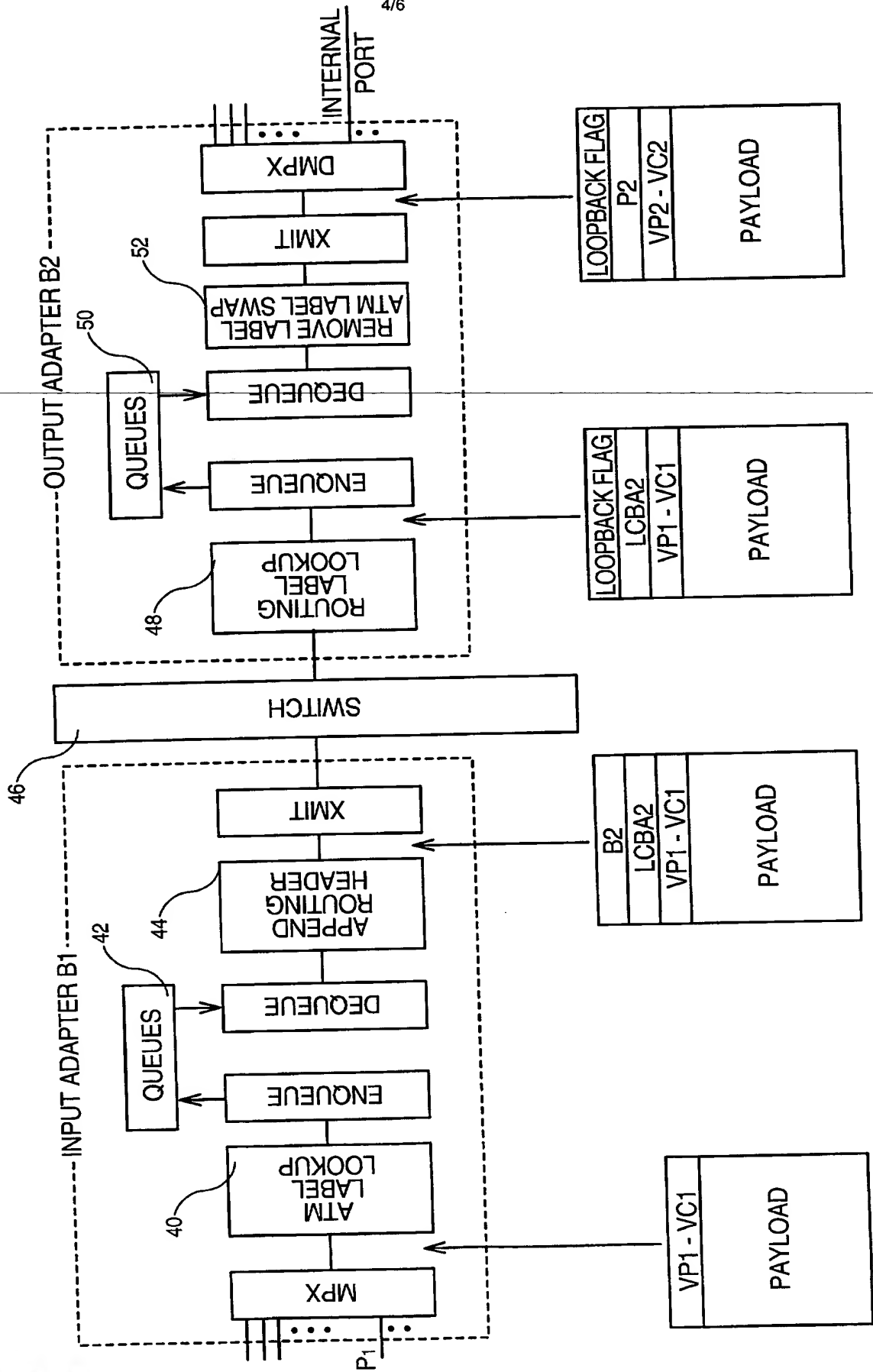


FIG. 4

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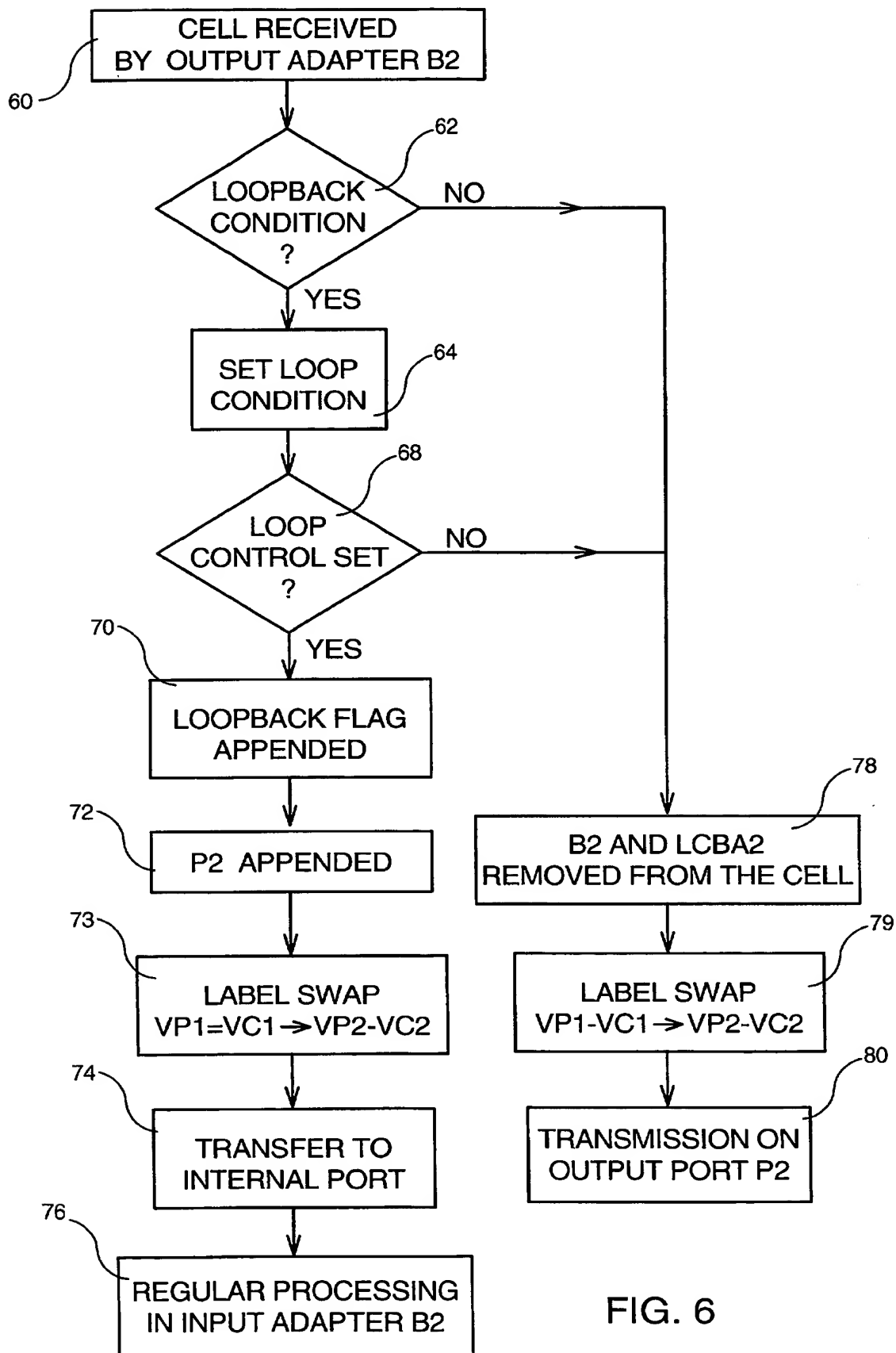


FIG. 6

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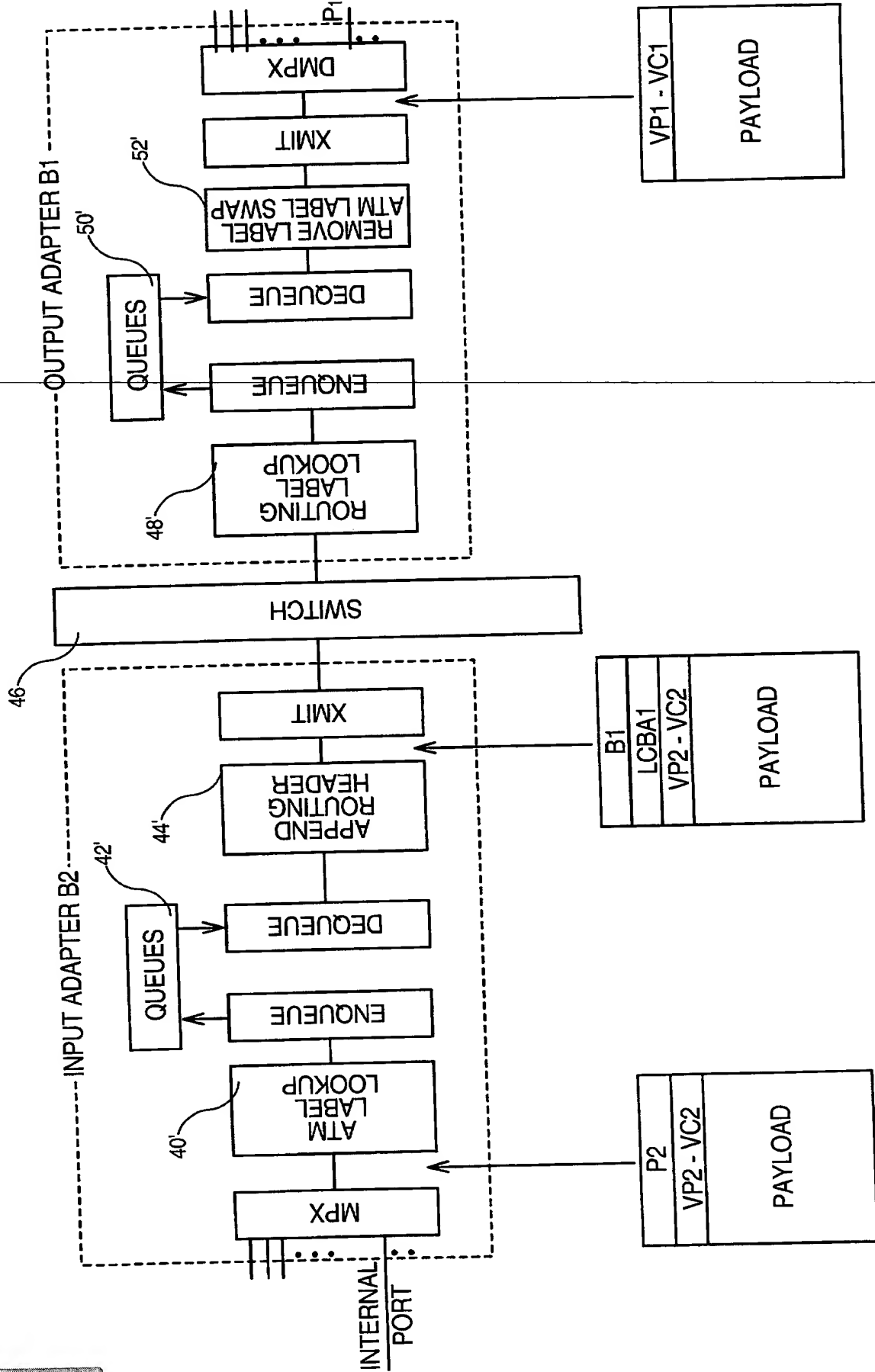


FIG. 5